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ADDENDUM NO. 1
Waterford Estates 24-Inch Trunk Sewer
E.O. No. 79443
T.C. No. 801645
Lincoln, Nebraska - 2007
Spec. No. 07-294

TO ALL WHO HAVE RECEIVED PLANS AND SPECIFICATIONS FOR THE REFERENCED PROJECT.

SCOPE

This Addendum covers the following additions, modifications, and clarifications to the Drawings and Specifications for this project.

SPECIFICATIONS

1. Refer to the MATERIAL AND CONSTRUCTION SPECIFICATIONS in the SPECIAL PROVISIONS TO THE GENERAL CONDITIONS & REQUIREMENTS.
   a. Add the attached Specification Section titled, "SECTION 02315 MICROTUNNELING" to Division 2 - Sitework.

Each Bidder must acknowledge receipt of all addenda in the space provided on the Proposal form.

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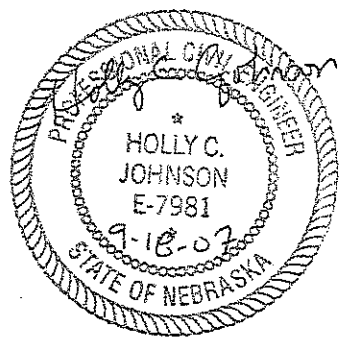

SECTION 02315

MICROTUNNELING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Construction of sanitary sewers by one-pass remotely controlled tunneling operation, generally without man entry. The construction method involves jacking pipe behind a micro-tunnel boring machine (MTBM) with the pipe serving as both the tunnel liner during construction and sanitary sewer pipe after completion of construction. This Specification is intended to be primarily functional in nature and to define in general terms the Work to be accomplished. The Contractor shall have full discretion to select the method of tunnel construction, subject to review by the Engineer.

B. Contractor may select centrifugally-cast fiberglass reinforced plastic mortar pipe (CCFPM) or vitrified clay pipe (VCP).

C. Contractor shall be responsible for the final constructed product, materials, and tools used, and for furnishing the labor and qualified superintendents necessary for the selected method of construction.

D. The Contractor must demonstrate that the chosen method will prevent flow of water or soil into the tunnel and provide stability of the face under anticipated conditions.

E. The Contractor shall furnish all items, including but not limited to, the MTBM, automated spoil transportation systems, hoists, signal systems, safety equipment and survey controls, necessary to excavate and advance the tunnel and construct the sanitary sewer by the selected method.

1.2 REFERENCE STANDARDS

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the abbreviation only.

A. American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering, applicable sections

B. American Association of State Highway and Transportation Officials (AASHTO).

C. American Society for Testing and Materials (ASTM).

1. ASTM C700 - Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated.

2. "Greenbook" Standard Specification of Public Works Construction.

3. ASTM C1208/1208M - Standard Specification for Vitrified Clay Pipe and Joints for use in Jacking, Sliplining, Pipe Bursting and Tunnels.

4. ASTM D3262 - Standard Specification for Fiberglass (Glass-Fiber-Reinforced-Thermosetting-Resin) Sewer Pipe

5. ASTM D3754 - Standard Specification for Fiberglass (Glass-Fiber-Reinforced-Thermosetting-Resin) Pipe in a Deflected Condition

6. ASTM D3754 - Standard Specification for Fiberglass (Glass-Fiber-Reinforced-Thermosetting-Resin) Sewer and Industrial Pressure Pipe

D. Occupational Safety and Health Administration (OSHA) - Particular attention is called to Subpart S of the OSHA Standards (29 CFR 1926/1920), published as U. S. Department of Labor Publication 2207, Revised October 1, 1979. Second revision dated August 1, 1989. See Federal Register dated June 2, 1989 for revised standard and commentary.

1.3 DEFINITIONS

A. Tunneling Work Plans shall be defined as written descriptions, together with sketches, drawings, schedules, and other documents defining Contractor's plans and procedures for tunneling. The submission of Tunneling Work Plans, including drawings, shall be required for the sole purpose of providing the Engineer sufficient details to verify that the Contractor's planned work and work in progress is in accordance with the intent of the Project design and specification requirements.

B. Jacked pipe shall be defined as the Contractor's sewer pipe that serves as initial construction lining and tunnel support, installed by the Contractor for stability and safety during construction, and as the sewer pipe. Such method of construction shall be of the Contractor's choosing, in accordance with this Specification. The listing of methods or reviews by the Engineer of Contractor's submittal shall not be construed by the Contractor as an endorsement by the Engineer that all such methods are constructible or will work for the specific subsurface soils encountered.

C. Microtunneling shall be defined as a method of installing pipe by jacking the pipe behind a remotely-controlled, steerable, guided, articulated MTBM. The MTBM, which is connected to and shoved forward by the pipe being installed, shall be such that the soils being excavated are fully controlled at all times.

1.4 SUBMITTALS

A. Review. Submittals shall be made in accordance with the General Conditions and Requirements. The Engineer will review submitted plans, details and data for compliance with the requirements of this Section. Such review shall not be construed to relieve the Contractor in any way of responsibilities under the Contract. Contractor shall not commence work on any items requiring a Tunneling Work Plan or other submittals until the submittals have been reviewed and accepted by the Engineer. Structural designs and other engineered components shall be signed and sealed by a Professional Engineer registered in the State of Nebraska.

B. Microtunneling Operation.

1. Submit for review a Tunneling Work Plan with complete drawings and written description identifying details of the proposed method of construction and the sequence of operations to be performed during construction, as required by the method of tunneling. The drawings and descriptions shall be sufficiently detailed to demonstrate to the Engineer that the proposed materials and procedures will meet the requirements of this Section.

2. Depending on the Contractor's method of construction, the Tunneling Work Plan, including drawings, shall be submitted on the following items:

   a. Arrangement drawings and technical specifications of the MTBM and trailing equipment (including any modifications), experience record of the Contractor, experience and training records for the equipment operator with this type of machine, and a copy of the manufacturer's operation manual for the machine.

   b. Method of controlling line and grade of tunneling operation.

   c. Method and details of spoil removal, including equipment type, surface storage, processing, and disposal.

   d. Electrical system.

   e. Proposed contingency plans for critical phases and areas of tunneling.

   f. Grouting techniques to be used for over excavation, if any, including equipment, pumping and injection procedures, pressure grout types, and mixtures.

g. Details of the pipe jacking method and operation including jack setup, for jack thrust reaction bearing, and pipe lubrication system.

h. Details of method proposed to cushion and distribute jacking forces at pipe joints.

i. Plans for storage and handling of pipe.

j. Ground water control system per requirements in this section and in accordance with Section 02801 - Control of Ground Water and Surface Water, as required by construction method.

3. Submit for review, the layout and design of proposed access shafts in accordance with Section 02308 - Tunnel Shafts.

4. The following specific submittals are required if centrifugally-cast fiberglass reinforced plastic mortar pipe is used for the sewer pipe:

a. Design calculations for the proposed centrifugally-cast fiberglass reinforced plastic mortar pipe.

b. Properties, definition of strength criteria, and properties required by the referenced design standards of centrifugally-cast fiberglass reinforced plastic mortar pipe and joints.

c. Details of the proposed centrifugally-cast fiberglass reinforced plastic mortar pipe and joints.

d. Details of the centrifugally-cast fiberglass reinforced plastic mortar pipe connections to existing sewers and proposed structures and manholes.

e. Test reports from independent testing laboratories certifying that the sewer pipe has been tested in accordance with and exceeds minimum requirements of ASTM D3262 and ASTM D3681.

5. The following specific submittals are required if vitrified clay pipe (VCP) is used for the sewer pipe:

a. Design calculations for the proposed VCP.

b. Properties, definition of strength criteria, and properties required by the design.

c. Structural details of the proposed VCP including joint details.

d. Details of VCP connections to existing sanitary sewers, and manholes.

e. Test reports from independent testing laboratories certifying that the sewer pipe has been tested in accordance with and exceeds minimum requirements of ASTM C700 and ASTM C301.

C. Quality Control Methods. At least 30 days prior to the start of tunneling, the Contractor shall submit to the Engineer a description of the quality control methods proposed for tunneling operation. The submittal shall include:

1. Supervision. Supervisory control to ensure that work is performed in accordance with the Drawings and Specifications, and the Tunneling Work Plan.

2. Line and grade. Procedures for surveying, controlling and checking line and grade, including field forms.

3. Tunneling Observation and Monitoring. Procedures for preparing and submitting daily logs of tunneling operations, including field forms, to meet the requirements of Paragraphs 3.6 and 3.7.

4. Products and Materials. A plan for testing and submittal of test results to demonstrate compliance with the Specifications and Contractor's design criteria for permanent products, materials, and installations. The plan shall identify applicable standards and procedures for testing and acceptance.

5. Monitoring Instrumentation. Monitoring Plan to meet the requirements of Paragraph 3.9A, Monitoring Instrumentation.

   a. Name of instrument installation subcontractors.

   b. Layout of instrumentation points.

   c. Procedures, forms and schedules for periodic submittals of readings.

6. Settlement Survey Plan, to meet the requirements of Paragraph 3.9C, Settlement Surveying. This plan can be submitted as a part of the Instrumentation Monitoring Plan.

7. Building Condition/Assessment Plans. Building Condition/Assessment plan, to meet the requirements of Paragraph 3.9B, Buildings and Structures Assessment.

D. Geotechnical and Environmental Investigation. The results of geotechnical and environmental investigations performed by Contractor as relevant to tunneling shall be included in the Tunneling Work Plan.

E. Safety. Procedures to meet all applicable OSHA requirements. These procedures shall be submitted for record purpose only and will not be subject to review or approval by the Engineer. As a minimum provide for:

1. Protection against soil instability and ground water inflow.

2. Safety for shaft access and exit, including ladders, stairs, walkways, and hoists.

3. Protection against mechanical and hydraulic equipment operations, and for lifting and hoisting equipment and material.

4. Ventilation and lighting.

5. Monitoring for hazardous gases.

6. Protection against flooding and means for emergency evacuation.

7. Protection of shaft including traffic barriers, accidental or unauthorized entry, and falling objects.

8. Emergency protection and self-rescue equipment.

9. Safety supervising responsibilities.

1.5 CRITERIA FOR DETERMINING CONSTRUCTION LOADS

A. The determination shall take into account, as a minimum, the loading criteria provided in the Geotechnical Report; long-term earth and hydrostatic loads; construction loads, such as erection and jacking forces; loads from handling and storing; and space necessary to install permanent structures.

B. The criteria to be used for truck loading shall be HS-20 vehicle loading distributions in accordance with AASHTO.

C. The criteria for longitudinal loading (jacking forces) on the pipe and joints shall be determined by the Contractor, based on the selected method of construction.

1. Calculations shall be made to determine face excavation forces and frictional factor.

2. The jacking equipment installed must have a capacity at least 20 percent greater than the calculated theoretical maximum jacking load.

D. The Contractor shall be responsible for selection of the appropriate pipe and pipe joints to carry the thrust of the jacks. Unless otherwise noted, any design indicated on the Drawings considers in-place loads only and does not take into account any construction loads.

E. Provide pipes of diameter shown on the Drawings. Substitution of pipe with larger diameter to suit MTBM equipment will only be permitted if the Contractor can demonstrate that design flows and velocities can be achieved.

F. Compatibility of Methods

1. The methods of tunneling, pipe jacking, ground stabilization, and ground water control shall be compatible.

2. The jacked pipe shall be selected to withstand the thrust without damage or distortion. The propulsion jacks on the shield shall be configured so that the thrust is uniformly distributed and will not damage or distort the pipe.

3. The tunneling method must be compatible with possible restrictions on the work, such as influence on existing installations, or potential ground water contamination, if any.

1.6 JOB CONDITIONS

A. Safety Requirements

1. Perform work in a manner to maximize safety and avoid exposure of men and equipment to hazardous and potentially hazardous conditions, in accordance with applicable safety standards and Contractor's safety procedures.

2. Whenever there is an emergency or stoppage of work which may potentially endanger the tunnel excavation, surface facilities such as roads and utilities, or adjacent structures, operate a full work force for 24 hours a day, including weekends and holidays, without intermission until the emergency or potentially hazardous conditions no longer jeopardize the stability and safety of the Work.

3. Perform tunneling operations in a manner that will minimize the movement of the ground in front of and surrounding the tunnel. Minimize subsidence of the surface. Prevent damage to structures and utilities above and in the vicinity of the tunneling operations.

4. Support the ground continuously in a manner to prevent loss of ground and keep the perimeters and faces of the tunnel and bottoms of the shafts stable.

B. Air Quality

1. Conduct operations by methods and with equipment which will positively control dust, fumes, vapors, gases, or other atmospheric impurities in accordance with OSHA, Federal, State, and City requirements.

2. Provide approved instrumentation for testing the quality of the air in manned work areas. Obtain samples under working conditions at prescribed intervals in accordance with the above-referenced requirements. Submit the results of the air quality tests to the Engineer each week.

PART 2 PRODUCTS

2.1 SEWER PIPE

A. The sanitary sewer pipe may consist of centrifugally-cast fiberglass reinforced plastic mortar pipe (CCFPM) or vitrified clay pipe (VCP).

B. Contractor shall be responsible for selecting appropriate pipes and pipe joints to safely carry the loads imposed during construction, including jacking forces. Pipe joints shall be flush with the outside pipe face when the pipes are assembled.

2.2 CENTRIFUGALLY-CAST FIBERGLASS REINFORCED PLASTIC MORTAR PIPE

A. Provide centrifugally-cast fiberglass reinforced plastic mortar pipe, joints, and fittings in accordance with Section 02641 - Centrifugally-Cast Fiberglass Reinforced Polymer Mortar Pipe.

2.3 VITRIFIED CLAY PIPE

A. Provide vitrified clay pipe with all joints and fittings in accordance with Section 02619 - Vitrified Clay (VCP) Sewer Pipe.

PART 3 EXECUTION

3.1 PREPARATION

A. The Contractor shall be responsible for means and methods of tunneling and pipe jacking operations and shall ensure the safety of the work, the Contractor's employees, the public, and adjacent property, whether public or private.

B. Execute tunneling operations so that ground settlement or loss will be minimized. The completed sewer pipe shall have full bearing against earth; no voids or pockets will be left in any portion of the Work. Fill the peripheral space between the installed sewer pipe and the ground with bentonite lubricating material during the jacking of the sewer pipe into its final location. Backgrout all pipe jacked sewer pipe in accordance with Section 02330 Tunnel Grout. If loss of ground occurs, fill the resulting void with suitable material, such as grout, as accepted by the Engineer. This may require jacking of the pipe be discontinued and additional access shafts installed at no additional cost to the City.

C. Maintain clean working conditions inside the jacking operation area and remove spoil, debris, equipment, and other material not required for operations.

D. In man-entry-sized pipes, intermittent entry of personnel will be permitted for maintenance and removal of equipment provided that all safety precautions are in place and functional.

E. For tunneling under railroad embankments, highways, or streets, perform the installation so as to prevent interference with the operation of the railroads, highways, or streets.

3.2 GROUND WATER CONTROL AND GROUND STABILIZATION

A. Portions of the excavation may be below the ground water table and in cohesionless soils, even if not indicated on the soil borings, and in conditions which may require a ground water control system for the tunneling operations. Provide the necessary ground water control measures at the site to perform the Work, to provide safe working conditions, and to prevent excessive inflow of water into the excavation during jacking operations.

B. Use eductors, well pointing, deep well pumping, or other means to remove water and to achieve stable conditions. Apply measures as described in Section 02801 - Control of Ground Water and Surface Water. If dewatering is the sole means of ground water control, draw water level down below the elevation of the invert of the sewer pipe.

C. Tunneling operations for which ground water control is necessary shall not proceed until monitoring data show that it is safe to do so.

D. The dewatering method used shall not cause damage to adjacent structures or property due to lowering of the water table and subsequent ground settlement. Contractor's dewatering method shall provide means for controlling water inflows to prevent inflow of fines and other adverse effects due to ground water. In the event any damage does occur, the Contractor shall be fully responsible for correction of damage and settlement of any claims arising from such damage.

E. Install and maintain an instrumentation system to monitor the water level and to detect any movement in adjacent structures and property. Monitor the water level by recording the initial water level before dewatering is started and thereafter on a weekly basis. Remove water monthly from the piezometers to demonstrate that they are operable. Submit weekly reports of the water levels to the Engineer. The Engineer will have access to the piezometers at all times to perform independent measurements.

F. If eductors, well points, or deep wells are used, space them adequately to provide the necessary ground water control. Sand packing and other means shall be used to prevent pumping of fine sands or silts from the subsurface and to minimize ground subsidence. Ensure that subsurface soil is not being removed by the dewatering operation or subsurface drainage into the shafts.

G. Keep sufficient pumping equipment and other machinery available at the site to assure that the operation of the dewatering system can be maintained.

H. The dewatering system shall remain in operation until the sewer pipe is installed.

3.3 EQUIPMENT

A. No gasoline-powered equipment shall be permitted in the tunneling operation or shafts. Diesel, electrical, or air-powered equipment will be acceptable, subject to applicable federal and state regulations. Use diesel engines equipped with scrubbers.

B. Microtunnel Boring Machine. Contractor shall employ equipment that will be capable of handling the various anticipated ground conditions. In addition, the MTBM shall:

1. Have a face which is capable of maintaining the tunnel face under wet and adverse soil conditions and preventing loss of ground through the machine. The MTBM shall provide satisfactory support of the excavated face at all times.

2. Be articulated to allow steering.

3. Incorporate a suitable seal between the MTBM and the leading pipe to prevent loss of bentonite.

4. Electric or hydraulic motors and operating controls to be protected against water inflows.

5. Use a bidirectional drive on the cutter head wheel and adjustable fins to control roll.

C. Automated Spoil Transportation. Provide an MTBM which includes an automated spoil transportation slurry (paragraph 3.3D.1) or a cased auger system (paragraph 3.3D.2) which shall:

1. Balance the soil and ground water pressures by the use of a slurry pressure balance system. System shall be capable of adjustments required to maintain face stability for the particular soil condition to be encountered on the Project and shall monitor and continuously balance the soil and ground water pressure to prevent loss of slurry or uncontrolled soil and ground water inflow.

    a. In a slurry spoil transportation system, Manage the pressure at the excavation face by use of the slurry pumps (which may be of variable speeds), pressure control valves, and a flow meter.

    b. Include a slurry bypass unit in the system to allow the direction of flow to be changed and isolated, as necessary.

    c. Provide a separation process when using the slurry transportation system. Design it to provide adequate separation of the spoil from the slurry so that slurry with a sediment content within the limits set by the Tunneling Work Plan can be returned to the cutting face for reuse. Appropriately contain spoil at the site prior to disposal.

    d. Use the type of separation process suited to the size of tunnel being constructed, the soil type being excavated, and the work space available at each work area for operating the plant.

    e. Carefully monitor the composition of the slurry to maintain the slurry weight and viscosity limits defined by the Tunneling Work Plan.

2. Balance ground water pressures by the use of a cased auger earth pressure balance system. Use a system capable of adjustments required to maintain face stability for the particular soil condition to be encountered. Monitor and continuously balance the soil and ground water pressure to prevent loss of soil or uncontrolled ground water inflow.

    a. In a cased auger spoil transportation system, manage the pressure at the excavation face by controlling the volume of spoil removal with respect to the advance rate. Monitor the speed of rotation of the auger flight, and the addition of water.

    b. Submit an evaluation of the equipment's ability to balance soil and water pressures at the face, stability of the soils, and the significance of the ground water present, for the Engineer's review where an auger soil transportation system is proposed for use by the Contractor in the presence of ground water.

D. Pipe Jacking Equipment. Provide an MTBM operation which includes a pipe jacking system with the following features:

1. Has the main jacks mounted in a jacking frame located in the starting shaft.

2. Has a jacking frame which successively pushes the MTBM along with a string of connected pipes toward a receiving shaft.

3. Has sufficient jacking capacity to push the MTBM and the string of pipe through the ground. Pipe jacking equipment shall incorporate intermediate jacking stations if required.

4. Has hydraulic cylinder extension rates which are synchronized with the excavation rate of the MTBM, as determined by the soil conditions.

5. Develops a uniform distribution of jacking forces on the end of the pipe by use of spreader rings and packing.

6. Provides and maintains a pipe lubrication system at all times to lower the friction developed on the surface of the pipe during jacking.

E. Remote Control System. Provide an MTBM which includes a remote control system with the following features:

1. Allows for operation of the system without the need for personnel to enter the tunnel. Have a display available to the operator, at an operation console, showing the position of the shield in relation to a design reference together with other information such as face pressure, roll, pitch, steering attitude, valve positions, thrust force, and cutter head torque; rate of advance and installed length.

2. Integrates the system of excavation and removal of spoil and its simultaneous replacement by pipe. As each pipe section is jacked forward, the control system shall synchronize all of the operational functions of the system.

F. Active Direction Control. Provide an MTBM which includes an active direction control system with the following features:

1. Controls line and grade by a guidance system that relates the actual position of the MTBM to a design reference (e.g., by a laser beam transmitted from the jacking shaft along the centerline of the pipe to a target mounted in the shield).

2. Is capable of maintaining grade to within plus or minus ½ inch and line to within plus or minus 2 inches.

3. Provides active steering information which shall be monitored and transmitted to the operating console.

4. Provide positioning and operation information to the operator on the control console.

G. Provide portable testing equipment at the jacking station for carbon monoxide gas, hydrogen sulfide gas, oxygen deficiency, and explosive gases.

H. Equip all electrical systems utilized on the MTBM with appropriate ground fault systems. Use electrical systems that are insulated, not permitting any bare wire exposures.

I. Uses generators which are suitably insulated for noise ("hospital" type) in developed areas.

J. Necessary equipment for sewer pipe excavation shall include signal systems, fire extinguishers, safety equipment, and other equipment required by the Contractor's method of construction. Such equipment shall be maintained in good repair.

3.4 SHAFTS

A. Construction of Shafts. Shafts, with or without permanent structures in them, shall be constructed in accordance with Section 02308 - Tunnel Shafts. Contractor shall have sole responsibility to select the size of tunneling shafts to suit his selected method of construction and equipment.

B. Thrust Blocks. Use thrust blocks for pipe jacking that are properly designed and constructed. Position thrust blocks normal to the proposed pipe alignment. Thrust blocks shall be designed to support the maximum obtainable jacking pressure developed by the main jacking system. Special care shall be taken when setting the pipe guide rails in the jacking shaft to ensure correctness of the alignment, grade, and stability. If a concrete thrust block or treated soil zone is used, concrete or other materials shall have attained the required strength before jacking begins.

3.5 EXCAVATION AND JACKING OF PIPE

A. Tunnel Excavation

1. Conduct tunneling operations in accordance with applicable safety rules and regulations and use methods which include due regard for safety of workmen, adjacent structures, utilities, and the public.

2. Keep tunnel excavation within the easements and rights-of-way indicated on the Drawings, to the lines and grades designated on the Drawings.

3. Locate equipment powered by combustible fuels at suitable distances from shafts and protect equipment to prevent the possibility of explosion and fire in shafts or the sewer pipe.

4. During excavation, carefully control volume of spoil removed.

5. Advancing Shield. During forward movement of the shield, provide sufficient support at the excavation face to prevent loss of ground into the MTBM.

6. Size of Tunnel Excavation. Make the excavation of a minimum sufficient size to permit pipe installation by jacking with allowance for bentonite injection into the annular space.

B. Pipe Jacking

1. For jacking, use pipe that is round with a smooth, even outer surface, and has joints that allow for easy connections between pipes. Pipe ends shall be designed so that jacking loads are evenly distributed around the entire pipe joint and such that point loads will not occur when the pipe is installed. Pipe used for pipe jacking shall be capable of withstanding all forces that will be imposed by the process of installation, as well as the final in-place loading conditions. Protect the driving ends of the pipe and joints against damage.

2. Cushion pipe joints with a plywood ring between joints, or by other methods to transmit the jacking forces without damage to the pipe or pipe joints.

3. Use rubber gaskets to make the joints watertight.

4. Maintain an envelope of bentonite slurry, or other similar material, around the exterior of the pipe during the jacking and excavation operation to reduce the exterior friction and possibility of the pipe seizing in place. Water jetting of the ground to advance the pipe shall not be permitted.

5. If the pipe "freezes" and the Contractor is unable to move it again, the Contractor may be permitted to construct a recovery access shaft, with the location subject to review by the Engineer. The Contractor shall be solely responsible for obtaining approvals for such an intermediate shaft and shall be solely responsible for costs associated with the location and construction of the shaft and for maintaining traffic and utilities in the area.

6. In the event a section of pipe is damaged during the jacking operation, or joint failure occurs, as evidenced by visible ground water inflow or other observations, use one of the following procedures to correct the damage, as directed by the Engineer.

   a. Slightly damaged pipe which passes leakage test and maintains pipe barrel and joint structural integrity, may, if access is possible, be repaired in place with a method approved by the pipe supplier subject to review by the Engineer.

   b. Severely damaged pipe, or pipe where joint failure is evident, shall be removed from the excavation by jacking it through the excavation and removing it at receiving shaft subject to review by the Engineer.

C. Grouting

1. Backgrout sewer pipe after it is installed in its final location. Backgrouting shall completely fill voids outside the limits of the excavation created by caving or collapse of earth cover over the excavation. Fill with pressure-injected sand cement grout.

2. Furnish and operate suitable equipment for any required grouting operations depending on the condition of the application.

3. Take care in grouting operations to prevent damage to adjacent utilities or other properties. Grout at a pressure that will not distort or imperil any portion of the work or existing installation or structures.

4. Additional grouting requirements are defined in Section 02330 - Tunnel Grout.

3.6 JACKING OPERATION DATA

A. Logs of construction events and observations shall be submitted for each shift within 24 hours of the operations on at least the following:

1. Location of MTBM face by station and progress of tunnel drive during shift.

2. Hours worked per shift.

3. Completed field forms for checking line and grade, with achieved tolerance relative to design alignment. Copies of steering control data will generally be acceptable.

4. Maximum jacking pressures per shove.

5. Location and brief soil descriptions of significant soil strata.

6. Ground water control operations and piezometric levels.

7. Observation of lost ground or other ground movement.

8. Indications of damaged pipe joint on pipe.

9. Any unusual conditions or event.

10. Operation shut-down periods or other interruptions in the work with reasons.

3.7 CONTROL OF LINE AND GRADE

A. Construction Control

1. The baseline and benchmarks are indicated on the Drawings. Contractor shall check baseline and benchmarks at the beginning of the Work and report any errors or discrepancies to the Engineer.

2. The Contractor shall use the baseline and benchmarks to furnish and maintain reference control lines and grades for the sewer pipe construction. Use these lines and grades to establish the exact location of the tunnel excavation, sewer pipe, and structures.

3. The Contractor shall establish and be responsible for accuracy of control for the construction of the entire Project, including access shaft locations, structures, excavation, pipe alignment, and grade.

4. Establish control points sufficiently far from the tunnel operation not to be affected by ground movement.

5. Maintain daily surveying records of alignment and grade. Submit three copies of these records to Engineer within 24 hours of the operation. The Contractor, however, shall remain fully responsible for the accuracy of his work and the correction of it, as required.

6. Check the primary control for the MTBM against an above-ground undisturbed reference at least once each week and once for each 50 feet of tunnel constructed, or more often as needed or directed by the Engineer.

B. Earth Movement. The Contractor shall be responsible for damage due to settlement from any construction-induced activities.

1. Contractor shall take precautions to avoid damage or settlement to buildings, structures, roads, and utilities in proximity to the work. Use construction methods and equipment to minimize loss of earth at the excavation face and settlement of earth around the sewer pipe.

2. Refer to the paragraph 3.9, Monitoring, in this Section for detecting earth movement.

3. In the event any movement of ground is detected, before proceeding the Contractor shall correct any problems causing or resulting from such movement.

4. The Contractor shall be aware that if settlement of the ground surface should occur during construction which will affect the accuracy of the temporary benchmarks, it shall be the Contractor's responsibility to detect and report such movement. Advise the Engineer of any settlement affecting the benchmarks. Upon completion, the field books pertaining to monitoring of the benchmarks shall be submitted to the Engineer.

C. Line and Grade

1. Contractor shall continuously monitor the line and grade of the tunnel excavation using a laser in the jacking shaft and a target in the MTBM.

2. Record the exact position of the MTBM at each shove to ensure the alignment is within specified tolerances. Make the survey at the MTBM to allow immediate correction of misalignment before allowable tolerances are exceeded. The tunnel guidance system may be used, however, the Contractor shall select times to measure and record this information after the air temperatures have stabilized throughout the pipe to ensure accurate readings.

3. When excavation is off line or grade, make alignment corrections to avoid a backfall in gravity sewers.

4. Perform a verification survey of the installed sewer pipe from shaft to shaft after removal of the MTBM. Document measured conformance to design line and grade of the pipe together with locations and deviation (distance and direction) of any out-of-tolerance locations.

5. Acceptance criteria for the sewer pipe shall be ± 6 inches in horizontal alignment from the theoretical at any point between manholes, including the receiving end, and ± 2 inches in elevation from the vertical.

6. If allowable tolerances are exceeded, the Contractor shall bear full responsibility and expense for correction (redesign, reconstruction, easement acquisition, etc.). If redesign is required, the Contractor shall obtain the services of a Professional Engineer registered in the State of Nebraska for the redesign. The installed pipe must be capable of meeting the design flow and velocities for a full pipe condition. Plans showing the changes shall be submitted to the Engineer for review.

7. Sewer pipe installed outside tolerance or which are outside of right-of-way or permanent easement shall be backfilled (grouted) and reconstructed within tolerance, if directed by the Engineer.

3.8 TUNNEL CONNECTIONS, TERMINATIONS, AND TEMPORARY BULKHEADS

A. Connect new tunnels to existing structures by removing existing bulkheads, if necessary, and sealing the junction as shown on Drawings.

B. Seal terminations of tunnels, which are not connected to permanent structures, by a temporary bulkhead.

C. Design temporary bulkheads where and when required. Provide bulkheads capable of resisting the lateral earth and hydrostatic pressures, waterproof, and capable of being removed without damaging the sewer pipe or plastic liner.

3.9 MONITORING

A. Monitoring Instrumentation. This specification establishes minimum instrumentation requirements for the tunneling work. Additional instrumentation requirements for critical areas may be specified elsewhere in the Specifications or on the Drawings. The Contractor may install a more extensive system at Contractor's sole expense, if needed. The instrumentation specified shall be accessible at all times to the Engineer.

1. The Contractor shall submit for review, prior to construction, a Monitoring Plan including instrument installation, instrumentation points location and layout, manufacturer's catalog literature, and installation reports formats.

2. Install and maintain a system of instrumentation to monitor the tunneling operation and to detect movement in the soil and adjacent structures. Instruments shall consist of no less than a sufficient number of inclinometers and crack monitors at bridge and adjacent structures and sufficient piezometers. Use monuments sufficiently removed from the construction to avoid errors in readings due to ground settlement.

3. Soil instruments such as piezometers, inclinometers, extensometers, and crack monitors shall be installed by a qualified subcontractor specializing in geotechnical work.

4. Extensometers shall be installed to a depth of 5 feet above the crown of the sewer tunnel to measure vertical movements in the soils during and subsequent to tunneling. The extensometer consists typically of a three-prong anchor, a 1/4-inch standard stainless steel inner pipe, and a 1-inch standard Schedule 80 PVC outer pipe. The pipes are assembled in sections and fastened together with standard couplings to the required anchor depths. The top of the extensometer shall be located within a flush-mounted handhole cover

capable of withstanding H-20 truck loading. The geotechnical instrumentation installation subcontractor shall provide procedures for installation of the extensometers; as a part of the Monitoring Plan.

B. Building and Structures Assessment. The Contractor shall submit for review prior to construction, a Building and Structures Assessment Plan. Preconstruction and post-construction assessment reports shall be provided for buildings and structures located within a distance equal to the depth of tunnel but at least 50 feet in plan from the proposed tunnel centerline and shafts. Photographs or a video of any existing damage to structures in the vicinity of the sewer alignment shall be included in the assessment reports.

C. Settlement Surveying. This specification establishes minimum settlement survey requirements for structures and ground surface monitoring points.

1. Submit a settlement surveying and monitoring plan for review prior to construction. The plan shall identify the location of settlement monitoring points, reference benchmarks, survey schedules and procedures and reporting formats.

2. Locate survey points on all structures within a distance equal to the depth of the tunnel but at least 50 feet in plan from the tunnel centerline.

3. Record the horizontal coordinates and elevations (with an accuracy of 0.01 feet) for each survey point location. Reference survey points so that they may be accurately re-established if lost or destroyed.

4. Unless otherwise specified, record the ground surface elevations on the centerline ahead of the MTBM at a minimum of 100-foot intervals or at least three locations per tunnel drive. Starting 100 feet ahead of the MTBM and continuing until the MTBM is 100 feet beyond the measurement point, unless otherwise directed by the Engineer.

5. Locate survey points at crossings under other installations as follows:

   a. Roads - Centerline and each shoulder

   b. Railroad Crossing - Track sub-base at center line of each track

   c. Utility and Pipelines - Directly above and 10 feet before and after the intersection.

6. For settlement surveys at shafts, see Section 02308 Tunnel Shafts.

D. Measure and maintain records of deformation of any non-rigid sewer pipe at convenient locations as defined by Contractor's monitoring plan.

E. Reading Schedule and Reporting. The Contractor shall submit readings from the various instruments and survey points daily to the Engineer. Reading frequency shall be increased as required by the Engineer when construction is approaching or near critical structures (structures, bridge piers, pipelines, etc., partially or entirely located within a distance equal to the depth of tunnel but at least 50 feet in plan from the tunnel centerline). Initial readings of surface points shall be taken before any excavation or construction is started.

1. Immediately report to the Engineer any movement, cracking, or settlement which is detected and take immediate remedial action. The Contractor shall be fully responsible for any such damage to adjacent structures.

2. At the end of construction (after the sewer pipe is installed, backgrouted, and dewatering is discontinued), make a final survey of all control points established for instrumentation and observation. The final readings shall be submitted to the Engineer. Make a visual inspection of all structures adjacent to the sewer pipe and report to the Engineer the condition of the structures, any damage incurred during construction, and corrective action taken.

3.10 DISPOSAL OF EXCESS MATERIAL

A. Remove spoil from the job site and dispose in accordance with Chapter 20 - Construction for Utilities and Structures.

END OF SECTION